JAN 28 2000

ENGINEERING DATA TRANSMITTAL

1. EDT 628665

2. To: (Receiving Organization) Nuclear Safety & Licensing	3. From: (Originating Organization) Equipment Engineering	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: RPP/TWO/PE/EE	6. Design Authority/Design Agent/Cog. Engr.: R. S. Robinson	7. Purchase Order No.: N/A

8. Originator Remarks:
This study evaluates the adequacy and benefit of use of HEPA filter differential pressure limiting setpoints to initiate exhauster shut down as an alternative safety control for postulated accidents that may result in filtration failure and subsequent unfiltered release.

9. Equip./Component No.: N/A

10. System/Bldg./Facility: HVAC/Exhausters/TF

11. Receiver Remarks:

11A. Design Baseline Document? ○ Yes ◉ No

12. Major Assm. Dwg. No.: N/A

13. Permit/Permit Application No.: N/A

14. Required Response Date: None

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	RPP-5594		0	Evaluation of Alternative Control for Prevention and/or Mitigation of HEPA Filter Failure Accidents at Tank Farm Facilities	ES	2	1	1

16. KEY

Approval Designator (F)	Reason for Transmittal (G)		Disposition (H) & (I)	
E, S, Q, D OR N/A (See WHC-CM-3-5, Sec. 12.7)	1. Approval 2. Release 3. Information	4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment	4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN
		Design Authority				1	1	D. H. Shuford	[signature]	27Jan00	R1-56
1	1	Design Agent R. D. Gustavson	[signature]	1/27/00	R1-56	1		C. J. Hopkins	[signature]	1/27/00	R2-50
1	1	Cog. Eng. R. S. Robinson	[signature]	1/27/00	R1-56	3		D. G. Baide			S5-05
1	1	Cog. Mgr. D. B. Smet	[signature]	1-27-00	R1-56	3		R. E. Larson			T4-07
		QA				3		J. J. Badden			S5-07
1	1	Safety C. E. Leach	[signature]		R1-44	3		M. D. Hasty			S7-01
1	1	Env. D. J. Carrell	[signature]	1-27-00	R1-51	3		T. L. Hissong			S7-20

18.	19.	20.	21. DOE APPROVAL (if required)
[signature] R. D. Gustavson 1/27/00 Signature of EDT Originator / Date	[signature] C. E. Leach 1/27/00 Authorized Representative for Receiving Organization / Date	[signature] D. B. Smet 1-27-00 Design Authority/ Cognizant Manager / Date	Ctrl No. ____ ○ Approved ○ Approved w/comments ○ Disapproved w/comments

Evaluation of Alternative Control for Prevention and/or Mitigation of HEPA Filter Failure Accidents at Tank Farm Facilities

Robert D. Gustavson
CH2M Hill
Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 628665	UC: 2000
Org Code: 74700	Charge Code: 109311
B&R Code: EW3130000	Total Pages: 39

Key Words: HEPA, Filter, Continuous Air Monitor(CAM), Differential Pressure, Exhauster, Safety Control, Interlock

Abstract: This study evaluates the adequacy and benefit of use of HEPA filter differential pressure limiting setpoints to initiate exhauster shutdown as an alternative safety control for postulated accidents that might result in filtration failure and subsequent unfiltered release from Tank Farm primary tank ventilators.

1/27/00
Release Approval Date

Approved For Public Release

RPP-5594
Revision 0

Evaluation of Alternative Control for Prevention and/or Mitigation of HEPA Filter Failure Accidents at Tank Farm Facilities

R. D. Gustavson
CH2M Hill Hanford Group, Inc.

Date Published
January 2000

Prepared for the U.S. Department of Energy

CH2MHILL
Hanford Group, Inc.

P.O. Box 1500
Richland, Washington

Hanford Management and Integration Contractor for the
U.S. Department of Energy under Contract DE-AC06-99RL14047

This page intentionally left blank

Executive Summary

This document presents an evaluation of the feasibility and adequacy of a proposed alternative control strategy for prevention and/or mitigation of a design basis unfiltered release of radioactive and hazardous materials from tank farm facility exhausters that might result from failure of High Efficiency Particulate Air (HEPA) filters. Justification is made for use of an alternative control as a revision to Limiting Condition of Operation (LCO) 3.1.4. of the River Protection Project (RPP) Authorization Basis (AB). The alternative safety control is to initiate automatic stack fan shutdown from HEPA filter differential pressure (dP) switches when low or high dP setpoints are exceeded, conditions that are indicative of failed or failing filtration. The current safety control for mitigation of this condition is initiation of automatic stack fan shutdown upon detection of high radiation levels in the stack air stream by Continuous Air Monitor (CAM).

This work was directed to be accomplished in Performance Incentive Number ORP3.2.3, *Implementation of Field Optimizations*.

The evaluation shows that the filter differential pressure option can: (1) successfully perform the safety function of LCO 3.1.4; (2) maintain the requisite level of safety control availability specified in the RPP FSAR; (3) increase safety control system reliability, thereby reducing risk posed to mission success by operational disruption, exhauster shut downs, and waste transfer terminations; (4) reduce the amount of operational and maintenance activities, thereby reducing plant life cycle costs and freeing resources to support other critical work; and (5) result in substantial cost avoidance and return on investment.

The alternative safety control is determined to be technically equivalent or better than the present control. Unlike the CAM/Fan Interlock control, the dP Switch/Fan Interlock control will prevent filtration failure for one of the accident scenarios, rather than simply mitigating an unfiltered release due to HEPA filter failure.

Even with implementation of the alternative control as a replacement of the current control, CAMs will still be required (without fan interlock) on exhaust stacks with the potential to emit airborne radioactive particulates in excess of environmental standards, commonly referred to as "major" stacks. However, implementation of the alternative control will allow the CAM

systems to be downgraded from a Safety Class or Safety Significant designation to a General Service classification, resulting in both significant O&M cost avoidance and increased stability for plant operations.

With implementation, reduced risk to mission will be realized. Increased equipment and system reliability will result in significant reduction in control system operability failures. This effectively reduces the potential for termination of both an exhauster's operation and concurrent waste transfers. Therefore, the probability of failure to provide continuous waste feed to the waste vitrification contractor is reduced, related contractual penalties are avoided, and the operational ability to continuously maintain tank headspace ventilation and vacuum is improved.

Implementation will result in an estimated annual cost avoidance of $721K in FY 2000 dollars. This is primarily due to an increase in equipment and system reliability, which will allow for maintaining a continued sufficient level of safety control availability with a significant reduction in frequency of operational surveillance, functional tests, maintenance, and occurrence reporting functions. Implementation costs ($2.8M) are estimated to be fully offset from cost avoidance by April of 2005, assuming completion of modifications by October 2001 (4.5 year payback). Plant life cycle return on investment is estimated to be $32.5M at FY 2034.

Section 3.0, *Background*, includes: a brief description of the system relied upon for safety control; the postulated accident scenarios for which the safety control was established to mitigate; applicable Technical Safety Requirements; and discussion of impacts to needed operational flexibility.

Section 4.0, *Differential Pressure Generation and Limitations*, provides background on pressure drop limitations of HEPA filters and bases for current specified HEPA dP operational limits.

Section 5.0 provides the technical justification for the adequacy of the alternative safety control. Section 6.0 discusses modification project scope, design concept, and estimated schedule and cost. Section 7.0 presents a summary level cost/benefit analysis.

LIST OF TERMS

AB	Authorization Basis
ASME	American Society of Mechanical Engineers
AWF	Aging Waste Facility
BIO	Basis for Interim Operation
CAM	Continuous Air Monitor
CHG	CH2M Hill Hanford Group, Inc.
dP	differential pressure
DCRT	Double-Contained Receiver Tank
DOE	Department of Energy
DST	Double-Shell Tank
ERDA	Energy Research and Development Administration
FSAR	Final Safety Analysis Report
GS	general service
HEPA	High Efficiency Particulate Air
h	hour
in.	inch or inches
LCO	Limiting Condition of Operation
LMHC	Lockheed Martin Hanford Corporation
O&M	operations and maintenance
ORP	Office of River Protection
ORPS	Occurrence Reporting and Processing System
OSD	Operational Specification Document
PLC	programmable logic controller
PM/S	Preventive Maintenance/Surveillance
rem	Roentgen-equivalent man
RPP	River Protection Project
SC	safety class
SS	safety significant
SSC	Structures, Systems, and Components
SST	Single-Shell Tank
Sv	Seivert
TBR	Technical Bases Review
TSR	Technical Safety Requirement
USAEC	U.S. Atomic Energy Commission
USQ	Unreviewed Safety Question
wg	water gauge

1.0 PURPOSE

This document presents an evaluation of the feasibility and adequacy of a proposed alternative control strategy for prevention and/or mitigation of potential unfiltered release of radioactive and hazardous materials from tank farm facility exhausters that might result from High Efficiency Particulate Air (HEPA) filter failures. These postulated accidents are presented in Chapter 3, and Section 3.0 of Addendum 1, of HNF-SD-WM-SAR-067 Rev. 1, *Tank Waste Remediation System Final Safety Analysis Report* (LMHC, 1999a), and they are summarized in Section 3.2 of this document.

Issuance of this engineering study by the River Protection Project (RPP) at Hanford satisfies a specific portion of the contractor performance expectations and requirements specified in DOE Office of River Protection (ORP) Performance Incentive Number ORP3.2.3, Revision 0 (DOE/ORP, 1999).

2.0 SCOPE

This document primarily provides the technical justification for modification of Limiting Condition of Operation (LCO) 3.1.4, *Ventilation Stack Continuous Air Monitor (CAM) Interlock Systems*, of HNF-SD-WM-TSR-006 REV 1, *Tank Waste Remediation System Technical Safety Requirements* (LMHC, 1999b). This revision would allow (on any applicable exhaust system) for the use of HEPA filter differential pressure switches to initiate automatic exhauster shutdown to prevent and/or mitigate accidental airborne release of radiological material. Currently the Technical Safety Requirements (TSRs) of the approved RPP Authorization Basis (AB) only have provisions for stack CAM/exhauster interlock as the control to mitigate postulated accidental release which may result from HEPA filtration failure.

The proposed use of HEPA filter differential pressure switches applies to those active ventilation systems currently meeting the criteria described in the Process Applicability Section of LCO 3.1.4 of LMHC 1999b. These include the following exhaust systems (while operating):

- primary tank exhausters for Double-Shell Tanks (DSTs) and Aging Waste Facility (AWF) tanks;
- active ventilation exhausters for Single-Shell Tanks (SSTs) at 241-C and 241-SX tank farms;
- exhausters for Double-Contained Receiver Tanks (DCRTs);
- the 204-AR Waste Unloading Facility exhauster (296-A-26); and
- portable primary tank ventilation systems.

Table 1 includes a listing of exhausters that are either currently applicable to LCO 3.1.4, or are expected to be applicable in future uses.

This study discusses and documents the feasibility of the proposed modification and the benefits from subsequent implementation. Benefits addressed include:

- enhanced safety control (preventive vs. mitigative);
- reduced risk of ORP mission failure;
- reduced maintenance and operation life-cycle costs;
- increased control system reliability;
- reduced occurrence reporting; and
- increased operational flexibility.

Also presented in this document are estimates of cost and schedule for implementation of the proposed safety control revision and field modifications. These estimates will support initiation of a directed baseline change prior to the implementation phase. It is presumed that a graded implementation will take place. Implementation includes but is not necessarily limited to the following activities:

- Baseline Change Request Process;
- design, procurement, modification, installation, and functional testing of field components/systems;
- development of maintenance, surveillance, and operational procedures;
- safety classification of components/systems and incorporation into equipment lists, spare parts inventory, Preventive Maintenance/Surveillance (PM/S) data sheets, and essential drawings,
- AB amendment activities, including Control Decision and Unreviewed Safety Question (USQ) processes, and
- personnel training.

Facility Exhauster	Stack Number	Applicability to LCO 3.1.4[1]	DP Switch Upgrade Needed?
241-AY/AZ Primary	296-A-42	Current	YES
241-AW Primary	296-A-27	Current	YES
241-AP Primary	296-A-40	Current	YES
241-AN Primary	296-A-29	Current	YES
241-SY Primary	296-P-23	Current	YES
241-SY Backup	296-P-28	Current	YES
241-SY Primary (new)	296-S-25	Future	YES
244-A DCRT Exhauster	296-A-25	Current	YES
244-BX DCRT Exhauster	296-B-28	Current	YES
244-CR Vault Exhauster	296-C-05	Current	YES
244-S DCRT Exhauster	296-S-22	Current	YES
244-TX DCRT Exhauster	296-T-18	Current	YES
244-U DCRT Exhauster	296-U-11	Future[2]	MAYBE[2]
241-C-105/106 Tanks	296-P-16	Current	YES
241-C-106 (W-320)	296-C-06	Current	YES
241-SX Tanks Exhauster	296-S-15	Current	YES
204-AR Unloading Facility	296-A-26	Current	YES
RMCS #B Portable	296-P-33	Future[6]	YES
RMCS #C Portable	296-P-34	Future[6]	YES
244-AR Tanks (RMCS #A)	296-P-32	Future[3]	MAYBE[3]
Portable Exhauster: POR03	296-P-42	Future[4]	NO[5]
Interim Stabilization Portable Exhauster: POR04	296-P-43	Current	NO[5]
Portable Exhauster: POR05	296-P-44	Future[4]	NO[5]
Portable Exhauster: POR06	296-P-45	Future[4]	NO[5]
Portable Exhauster: POR07	Not yet assigned	Future[4]	NO[5]
Portable Exhauster: POR08	Not yet assigned	Future[4]	NO[5]

[1] Applicable while operating.
[2] Currently not operating. If determined to have future mission use, exhauster will need dP switch upgrade.
[3] Currently not operating. Future use of portable exhauster for D&D activities at 244-AR will require USQ to determine applicability.
[4] Applicable if used to ventilate DST (including AWF), SST, or DCRT primary tank vapor spaces.
[5] Design incorporates desired HEPA dP measurement, switch, and control.
[6] AB submittal (Addendum 5) to incorporate RMCS into the FSAR was submitted in August 1998. RMCS exhausters will be required to meet LCO 3.1.4 when submittal is approved by DOE.

3.0 BACKGROUND

This section presents background information on ventilation filter systems, postulated accident scenarios, and related TSRs. Also discussed are the operational drivers for the need of an alternative to the current safety controls.

3.1 System Description

HEPA filter systems are provided on the subject ventilation exhaust systems to prevent emission of radioactive or toxic particulate material to the environment. With the exception of 296-A-26 (204-AR), all of the subject exhaust systems have two stages of HEPA filters installed in series within a filter "train" or housing, thereby providing redundant protection against unfiltered release should there be a single stage failure. The purpose of multi-stage HEPA filter series is to increase the reliability of the system by providing back-up filtration in the event of damage, deterioration, or failure of a single filtration stage. A HEPA filter stage may consist of either one single filter or a bank of multiple filters, depending on the particular system design.

On some systems, parallel HEPA filter trains exist, providing the capability to direct the exhaust air stream through either train. These configurations allow for continued operation of the ventilation exhaust system during testing, maintenance, or filter replacement activities.

Continuous exhaust stack radiation monitoring systems are configured prior to the emission point to detect releases from off-normal or postulated accident events. The exhaust stack monitoring systems include both a CAM and a proportional record sampler. The record sampler collects a composite sample to provide emission data for reporting purposes. The CAM monitors beta-gamma activity of the particulate matter in the emission air stream by continuously withdrawing a sample through probes mounted in the stack or duct. Interlocks automatically shut down the exhaust fan when high radiation levels are detected. The systems also have local and remote alarms that communicate failures of monitoring system equipment.

The CAM detects breakthrough of the ventilation system HEPA filters. The CAM and interlock protect against the continued unfiltered release of radiological and toxicological material following the breach of the filter.

3.2 Applicable Safety Analyses

Ventilation stack CAM interlocks are required for three accident scenarios:

1. Spray Leak in Structure or from Waste Transfer Lines
2. HEPA Filter Failure – Exposure to High Temperature or Pressure (Note: Controls for an unfiltered release are covered by this accident), and
3. Unfiltered Release (Waste Retrieval Sluicing System [WRSS]) operations.

3.2.1 Spray Leak in Structure or From Waste Transfer Lines

Spray leak scenarios are analyzed in the RPP FSAR (LMHC, 1999a). Based on the results of the analysis, the unmitigated release of radiological material could exceed offsite risk guidelines, and the release of radiological and toxicological material could exceed onsite risk guidelines. Ventilation stack CAM interlock systems decrease consequences of the accident below offsite and onsite risk guidelines.

The ventilation stack CAM interlock to the ventilation system exhaust fan is credited in the analysis to stop the ventilation system thereby terminating an unfiltered release. This action mitigates to below risk guidelines the potential consequences of a pressurized spray leak event when transferring waste.

The safety function of the ventilation stack CAM interlock systems is to shut down the exhaust fan when high radionuclide particulate activity is detected by the CAM, limiting radioactive material releases to the atmosphere and thus decreasing the consequences of the accident.

3.2.2 HEPA Filter Failure – Exposure to High Temperature or Pressure, or Unfiltered Release (WRSS)

The results of HEPA filter failure analyses are presented in the RPP FSAR (LMHC, 1999a). Based on the results of the analysis, the unmitigated release of radiological and toxicological material could exceed onsite risk guidelines. Ventilation stack CAM interlock systems decrease consequences of the accident below onsite risk guidelines.

The ventilation stack CAM interlock that detects a potential unfiltered release for SSTs with active ventilation (permanent or portable) only, DSTs, AWF tanks, and the 204-AR Waste Unloading facility is credited in the analysis to stop the ventilation system thereby terminating an unfiltered release. This action mitigates the potential consequences of an unfiltered release when a HEPA filter fire occurs or a high-pressure event occurs that affects the HEPA filter, to maintain radiological and toxicological consequences to below risk guidelines.

The safety function of the ventilation stack CAM interlock systems is to shut down the exhaust fan when high radionuclide particulate activity is detected by the CAM, limiting radioactive material releases to the atmosphere and thus decreasing the consequences of the accident.

3.3 Technical Safety Requirements

As discussed above, the ventilation stack CAM interlock to the ventilation system exhaust fan is credited in the safety analyses to stop the ventilation system through detection of high radionuclide particulate activity by the CAM, thereby mitigating an unfiltered release. This action is purely mitigative in that it decreases the potential consequences of an unfiltered release resulting from the postulated accidents to below onsite and/or offsite risk guidelines.

This section discusses both this control and a HEPA filter differential pressure switch control measure used previously during operation under the Basis for Interim Operation (BIO) at Tank Farm facilities and prior to full implementation of the RPP FSAR.

3.3.1 Limiting Condition Of Operation 3.1.4

In LCO 3.1.4 of the RPP TSR (LMHC, 1999b), the ventilation stack CAM interlock to the ventilation system exhaust fan is required to be operable whenever active ventilation (permanent or portable[1]) is operating. On the subject exhaust stacks, the CAM interlock actuates when the ventilation stack radiation level on the CAM filter paper exceeds a setpoint. For exhaust stacks equipped with newer model CAMs capable of measuring concentration, the CAM interlock actuates when the exhaust air radiation level is greater than a preset level. The interlocks shut down the ventilation system exhaust fan. This automatic interlock action stops continued unfiltered discharge of radiological and toxicological material through the ventilation stack following the breach of a filter. The interlock does not prevent a potential spray leak, unfiltered release, high-pressure, or high-temperature event from occurring, but mitigates the potential consequences by terminating further discharges through the ventilation stack.

[1] For portable ventilation systems, LCO 3.1.4 applies for the Spray Leak accident only (a) when the portable ventilation system is operating and (b) when the portable ventilation system is installed on tanks whose waste transfer system is physically connected to any active waste transfer pump that is not under administrative lock.

The accident analysis assumes that the CAM will actuate the exhauster fan interlock on increasing radiation that exceeds a preset level. A setpoint of 10,000 counts per minute (cpm) has been selected based on normal operating practice. However, the actual setpoint used is much lower to ensure loop error does not exceed the required 10,000 cpm setpoint.

The LCO ensures that the interlock is operable when active ventilation (permanent or portable) is operating. For a CAM and its associated interlock to be considered operable, it must measure the radiation level in the sampled flow stream, detect levels in excess of the preset level, and activate an interlock that will shut down the exhauster when the preset level is exceeded.

3.3.2 Limiting Condition Of Operation 3.1.4a

The compensatory control alternatives of LCO 3.1.4a, *HEPA Filter Differential Pressure and Stack High Radiation Systems*, are mentioned here as background information to demonstrate that both HEPA filter low dP interlock of ventilation fans and HEPA filter high dP alarms have been previously used as valid controls for mitigation of the applicable accident scenarios.

In Revision 0-B of the RPP TSR (LMHC, 1997), LCO 3.1.4a was implemented to provide HEPA filter differential pressure controls as a compensatory measure on those ventilation systems that did not yet have operable ventilation stack CAM interlocks as needed per LCO 3.1.4. The compensatory LCO applied to ventilation stack systems for: the 204-AR Waste Unloading Facility, 702-A, back-up exhauster 296-P-26, the 244-CR Vault, Tanks 241-C-105/106, and the primary tank exhaust systems in AN, AW, and AP tank farms when active ventilation was operating. These controls were valid through September 30, 1998. The bases for the compensatory controls is attached as Appendix A to this document.

LCO 3.1.4a required that stack exhauster interlocks (e.g., automatic fan shutdown) be initiated from *either* the stack CAM system upon detection of high radiation (‹10,000 cpm) *or* HEPA filter differential switches upon detection of low pressure drop ([0.2 in. wg) across a HEPA stage. Additionally, HEPA filter high differential pressure alarm was required to be operable for activation at high pressure differential (‹6.0 in. wg). These compensatory controls provided alternative mitigative protection for the accident scenarios discussed above in Section 3.2.

3.4 Operational Considerations

As discussed in the previous sections, CAM systems are relied upon to initiate automatic exhauster fan shutdown in the event of radiological release resulting from HEPA filter failure on the subject exhaust systems. The CAM systems are relatively complex, having multiple components in a dynamic flow system. They require many intrusive surveillance and maintenance activities, exhibit some design flaws that affect system reliability, and in general are cumbersome to maintain. In effect, they are prone to many types of failures.

CAM system and equipment reliability have been historically poor. To maintain high availability of operable CAM systems for safety control (>0.99 factor), a large amount of resources are applied to daily, bi-weekly, monthly, and quarterly surveillance and functional checks.

CAM system failures for the 24-month period from October 1997 through September 1999 were recently evaluated in RPP-5453, *Availability Analysis of the Ventilation Stack CAM Interlock System* (LMHC, 2000). In that study, 79 failure events were identified for 40 CAM locations (including annulus leak detection CAMs) that have Safety-Class or Safety-Significant designations. Of those 79 events, 51 were associated with CAM systems applicable to LCO 3.1.4. Based upon this data, the annualized rate of reportable occurrences for applicable CAM system operability is 25.5 reportable events per year.

Because these systems provide a safety function, system failures result in suspended operations, LCO action initiation, unscheduled maintenance, and occurrence reporting. Besides using significant resources and funding to follow through with LCO actions, critiques, occurrence reporting, and corrective action, these events have a large potential for negative effect on the mission and safe operation of the plant by shutting down exhausters and terminating waste transfers. As a minimum, LCO action statements require immediate waste transfer termination when CAM system operability is compromised, even though no accident has occurred and exhaust air radiation levels are not elevated. Because of the numerous and varied equipment and human factor problems associated with the CAM systems, continued reliance upon these systems to provide the subject safety function has a potential to have a substantial negative effect upon waste transfer operations in support of the RPP mission of waste feed delivery to the waste vitrification contractor.

Conversely, the envisioned HEPA differential pressure system considered in this study inherently employs a simple design with few interdependent components. The components themselves are not elaborate or complex. They are rugged and reliable. Recurring and periodic surveillance, maintenance, and operational activities are few and simple. The measurement of pressure drop is static rather than dynamic as is the case with CAM sample withdrawal and delivery, therefore there is a significant reduction in factors that affect reliability and operability.

Necessary components (solid-state dP transmitters, solid-state programmable logic controllers, tubing, wiring, etc.) are typically simple and robust with high reliability even in severe environments. For example, manufacturer's data for selected solid-state dP transmitters states an annual failure rate of one (1) in 300.

4.0 DIFFERENTIAL PRESSURE GENERATION AND LIMITATIONS

The following sections discuss how differential pressure is generated through a HEPA filter and what limitations exist.

4.1 Differential Pressure Generation

As an air stream passes through a HEPA filter, a differential pressure develops across the filter. This is because the filter acts as an obstruction in the air stream to a certain degree, thereby creating resistance to flow causing air pressure to be higher on one side (inlet) of the filter than the other (outlet). The difference between these two pressures is referred to as the differential pressure, or pressure drop, across the filter.

For a clean, newly installed filter, the initial resistance across the HEPA filter at rated flow is approximately 1.0 in. wg (per manufacturer's data). The penetration and airflow resistance of each HEPA filter unit is determined by the manufacturer before it is shipped from the factory, and quality assurance confirmation testing is accomplished onsite at Hanford as a condition of acceptance. As the filter begins to load with particulate and moisture over time during service, the resistance to flow becomes increasingly greater, and it becomes more difficult for the air to pass through the filter. As the loading increases, the differential pressure across the HEPA filter increases.

Conversely, if a HEPA filter structural failure were to develop, the resulting loss of integrity would cause a decrease in differential pressure across the filter stage. Essentially, the pressure differential would drop to near zero in the case of total or "catastrophic" failure of a filter, as assumed in the relevant accident analyses of the RPP FSAR.

4.2 HEPA Filter Differential Pressure Limitations

Specification documentation (HNF, 1999) used to procure HEPA filters on site requires that these filters be capable of withstanding a continuous differential pressure of 10 in. wg without failure per resistance to airflow performance testing specified in *American Society of Mechanical Engineers (ASME) AG-1*. As a bounding assumption, the accident analysis discussed in Section 3.2 for the HEPA failure due to over pressurization conservatively assumes failure to occur at 10 in. wg with an over pressurization event of any duration.

Results of destructive testing conducted by the U.S. Navy (USAEC, 1966) and presented in design guidance (ERDA, 1976) show that used filters are capable of withstanding a shock overpressure, for a 24" x 24" x 11 1/2" filter, of 49.87 in. wg and as high as 74.80 in. wg if face guards are installed. Filters with face guards on both faces have about 40% greater shock resistance than those without. Dirt-loaded filters exhibited about 15% less shock resistance than new filters. For new 24" x 24" x 11 1/2" filters with face guards installed, the recommended design value (ERDA, 1976) is 88.65 in. wg for the maximum shock overpressure that the filters should withstand without visible damage or loss in filtration efficiency when exposed to a shock of approximately 50 msec duration. For a 12" x 12" x 11 1/2" filter with face guards, 139.7 in. wg is the recommended maximum value. Additional testing conducted at Los Alamos indicates that a 12" x 12" x 11 1/2" filter can probably withstand a 9-second pulse of 69.3 in. wg without visible damage or reduction in efficiency (USAEC, 1973).

Tank farm facility operating specifications set the following limits for high pressure drop across HEPA filters:

(a) Maintain pressure drop across first filter in series to less than or equal to 5.9 in. wg.
(b) Maintain pressure drop across any other filter to less than or equal to 4.0 in. wg.
(c) Maintain total pressure drop across filters in a series to less than or equal to 5.9 in. wg.

The fundamental technical basis for these limits is outlined in Internal Letter 65260-80-0905, *AW Tank Farm Process Specifications* (Rockwell, 1980), which states in part: "The limit of 5.9 in. wg pressure drop across the first filter in a series provides a safety factor to allow for decreased filter strength due to aging and deterioration. This pressure drop (5.9 in. wg) is higher than the rest of the filters because the first filter will trap most of the material in the air stream, thus loading up much faster than the "downstream" filters. The 4 in. wg limit is set for the downstream filters to reduce the possibility of filter failure. This added safety factor is used since the downstream filters are the only remaining barrier to the atmosphere. The total pressure drop across the filters in series is limited to 5.9 in. wg so that a vacuum is maintained on the tank."

Rockwell 1980 further states: "The pressure drop limit of 5.9 in. wg for the first HEPA filter in a series has proved satisfactory from operational experience while providing an acceptable safety margin. Material buildup on a HEPA filter causes an increased pressure drop. HEPA filters used on the tank farms tend to "load up" slowly until a pressure drop of 2 to 3 inches water gauge is reached. Further pressure drop increases take place much faster. The 5.9 in. wg limit on the first filter is high enough so that an ample amount of time is available for filter changeout, which is normally done for all HEPA filters when the pressure drop approaches 3 in. wg. Since the downstream filters load up slowly, a 4 in. wg limit allows adequate time for filter changeout."

Currently, tank farm operators on surveillance rounds read HEPA filter dP on a daily basis, and the values are recorded on datasheets. Operational data review initiates work package development for filter changeout as filter loading approaches limits.

5.0 TECHNICAL JUSTIFICATION

The technical justification for the use of HEPA differential pressure switch/exhaust fan interlock as an alternative control for LCO 3.1.4 of HNF-SD-WM-TSR-006 Rev 1 is provided in the following sections.

5.1 HEPA Differential Pressure Interlock System

The system envisioned as an alternative control to CAM system/exhauster fan interlock systems consists of a simple and reliable system of pressure sensing, read-out, and switching control equipment (see Figure 1) that has proven to be reliable across the industry. Pressure differential can be statically measured across one or more HEPA filter stages as well as across the entire filter series or train. The preliminary design concept pictured in Figure 1 is one that provides a bounding case for implementation costs for the purposes of conservatively supporting the cost benefit analysis of Section 7.0. Actual functional design criteria may not include all the capabilities assumed in this concept. Design development and review will determine actual equipment component choices based upon functional requirements and costs.

Dependent on design requirement definition, local or remote dP indication can be provided for each measurement point to provide surveillance data for operational review. Differential pressure switches or transmitters will be provided for each required measurement point to cause interlocked shutdown of the associated exhauster upon reaching established high dP or low dP setpoints. Differential pressure alarms can also be provided to alarm at low dP, high dP, and high-high dP (interlock) setpoints. Although the system design could incorporate mechanical pressures switches and interlock relays, the use of a programmable logic controller (PLC) in the design would allow for consolidated setting of alarm and interlock setpoints and remote monitoring and alarm capability. A PLC could also provide the capability to read and trend dP rate-of-change, so that minor but rapid changes in filter dP conditions can be detected and investigated.

The use of solid-state dP transmitters and PLCs is the assumed design in this analysis because of improved reliability in extreme environmental conditions and transient pressure variations; improved accuracy; remote monitoring capability; reduced maintenance; and bounding implementation cost. The presented preliminary equipment design assumed in this analysis has been installed and in service on the newest RPP portable exhausters.

For the purposes of both technical justification and cost benefit analysis, it is assumed that after implementation the dP interlock system will replace the CAM interlock system as the LCO 3.1.4 safety function, and it will be given the same safety classification currently employed by the CAM interlock system.

5.1.1 HEPA Filter Stage Low Differential Pressure Setpoint

A low dP setpoint across a HEPA filter stage will ensure that the condition of a missing (e.g., gross failure) HEPA filter will be detected and will automatically cause the shut down of the ventilation fan or switchover to a redundant filter train. The recommended low differential pressure setpoint for the exhaust fan shutdown interlock, across each HEPA filter stage at rated flow, is 0.2 in. wg. For the preliminary design assumed in this study, this is the recommended TSR low dP limit for each stage. Actual limits will be defined during licensing and design activities. As an additional enhancement, the design could include a low dP alarm set to activate in advance of reaching the interlock setpoint or upon a set dP rate-of-change.

The initial pressure drop across a clean HEPA filter is approximately 0.8 to1.0 in. wg. at rated flow. The absence of filtration as postulated in accident scenarios will lower the pressure drop well below the bottom operating limit of 0.2 in. wg; essentially to zero pressure drop. This limit represents a conservative indication of filtration loss that will automatically and immediately shut down ventilation flow.

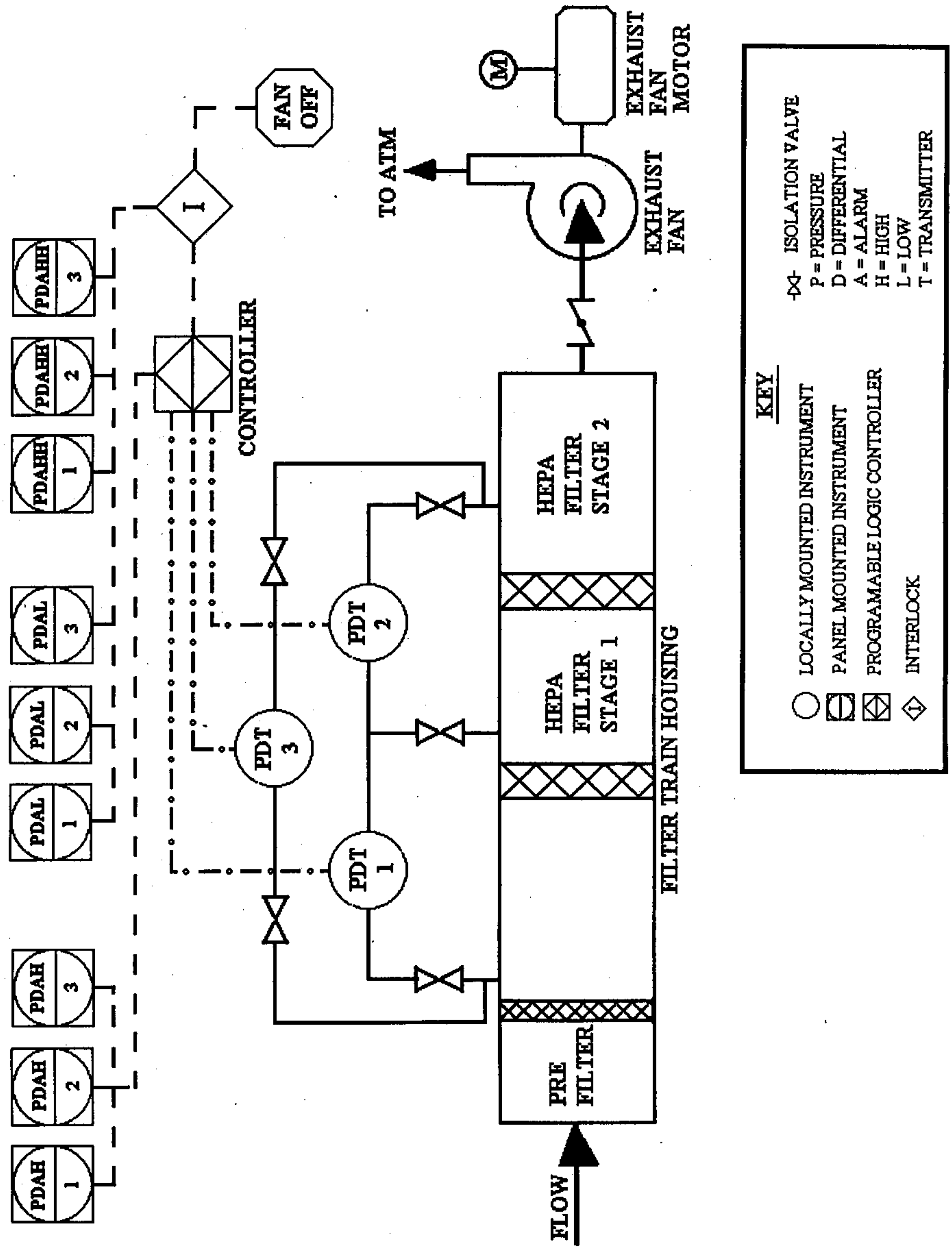

Figure 1 Simplified Piping & Instrument Diagram for HEPA Differential Pressure Switch Interlock System

Events where HEPA filters under normal operation fail to meet stringent annual HEPA particle penetration testing are few. Typically, these less than catastrophic filter failures have resulted in minuscule leakage past the filter-to-housing seal, which may or may not be detected as a change in differential pressure. In such instances, there would be insufficient material passing through the breach to exceed design basis accident consequences. If above background levels, radioactive material released from small leakage would show up on stack record samples. Past failure modes were typically from breakdown of the filter perimeter gel seal as a result of condensation of incompatible substances in the air stream (e.g., acetone, etc.), or from shrinkage of the gel seal. Seal composition has been improved over the years by the manufacturer to preclude chemically induced breakdown and shrinkage, and installation of ventilation system heaters has effectively reduced filter seal breakdown due to condensation. Additionally, the presence of multi-stage HEPA filter redundancy requires that double-contingency failure (e.g., two unrelated failures of HEPA stages) must occur for an exhaust system filter barrier to be breached.

5.1.2 HEPA Filter Stage High Differential Pressure Setpoint

High filter differential pressure is indicative of plugging of HEPA filters, which may be caused by material loading of aerosols generated in a spray leak. The high dP setpoint across a HEPA filter stage will ensure that moisture aerosol loading of filters due to a spray leak within the structure or tank will initiate interlocked shutdown of the ventilation exhaust fan, or switchover to a redundant train, *prior to HEPA filter failure*. Therefore, this control becomes preventive for the postulated unfiltered release of that accident scenario.

The recommended maximum high dP setpoints are 5.9 in wg for the first stage and 4.0 in wg for the second stage (and other stages, if more than two exist). Assuming that design definition requires high dP measurement and interlock across each filtration stage, these are the recommended maximum TSR limits for the interlock control. Actual limits will be defined during licensing and design activities[2]. As an additional enhancement, the design could include a high dP alarm set to activate in advance of reaching the interlock setpoint (e.g., 3.0 in. wg) or upon a set dP rate-of-change.

The procurement specification for HEPA filters requires that filters be capable of continuously withstanding differential pressure as high as 10 in. wg while maintaining the specified filtration efficiency. This is a very conservative

[2] Some of the applicable fans do not have the capacity to pull a vacuum sufficient to reach the recommended maximum high dP setpoints specified above. Actual high dP setpoints will be determined from fan performance curves during the design phase.

specification limit, as tests have shown that the filters can withstand much higher over pressurization without reduced performance. The specified limits provide an additional factor of safety, while simultaneously ensuring that the necessary vacuum is maintained within the ventilated tank or space[3].

5.1.3 Overall Filter Series Differential Pressure Setpoints

As additional control, filter trains with two (or more) stages of HEPA filtration may have a differential pressure transmitter measuring pressure across the entire set of HEPA filter stages. Differential pressure below the low setpoint or above the high setpoint would initiate interlocked shutdown of the ventilation system exhaust fan or automatic switchover to a redundant train. The recommended low differential pressure setpoint is 0.2 in. wg, and the recommended maximum high differential pressure setting is 5.9 in. wg. These are the recommended TSR limits for interlock control for the overall filtration train, assuming this additional control is determined necessary as a functional design requirement. Actual limits will be defined during licensing and design activities. As an additional enhancement, the design could include high dP alarm and or low dP alarm set to activate in advance of reaching the interlock setpoint or upon a set dP rate-of-change.

5.2 Prevention and Mitigation of Postulated Accident Scenarios

Resistance across a filter stage cannot be allowed to overcome an exhauster's ability to maintain negative pressure within the ventilated space. For each of the accident scenarios described in Section 3.2, the integrity of all of the HEPA filters in an exhauster's filtration train are compromised such that radiological and toxicological constituents are released unfiltered to the environment. In each case, full failure occurs for all the system HEPA filters currently operating, resulting in a postulated unmitigated release with an accident source term that has been evaluated for onsite and offsite consequences by comparison with DOE release guidelines.

Current controls (i.e., CAM/Fan Interlock) provide for termination of an unfiltered release resulting from the accident(s) by detecting increased radiation in the stack air stream followed by automatic shut down of the exhauster fan. This action is <u>mitigative</u> only in reducing the consequences of HEPA filter failure.

[3] Resistance across a filter stage cannot be allowed to overcome an exhauster's ability to maintain negative pressure within the ventilated space.

5.2.1 Prevention: Filter Failure from Spray Leak Accident

The use of a high dP measurement setpoint interlocked to shutdown the exhauster is a significant improvement of the level of safety control for the *Spray Leak in Structure during Waste Transfer* accident scenario. In this case, the "loading" of the filters with moisture from aerosols generated in the accident is detected *as it occurs*, and the exhauster is shutdown well before HEPA filter design failure limits are reached. Therefore, this control will act as a preventive action for this accident scenario. The HEPA filters, having not failed, will continue to provide their normal function of containment. By providing prevention of loss of filtration and containment, this alternative control is deemed to be a better control than the present CAM/fan interlock

The HEPA filter dP switch method is a commonly used control in the nuclear industry. It employs a simple static measurement system with high reliability and relatively low operating and maintenance costs. It is believed that the dP switch alternative should replace, as primary safety control, the existing CAM interlock system which is complex and has relatively high operation and maintenance costs related to its safety classification.

5.2.2 Mitigation: Filter Failure from High Heat or Over Pressurization

The use of a low dP measurement setpoint interlocked to shutdown the exhauster is an effective mitigation control for the *Exposure to High Temperature or Pressure* accident scenario. In this case, either a high temperature or a high pressure condition causes a complete failure of the filtration system to perform its function, resulting in an unfiltered release. Detection of LOW dP across a filter stage or across the entire filter train would actuate automatic shutdown of the exhauster fan, thereby terminating and mitigating the release.

From a technical view, this alternative control is deemed better in providing mitigation to the postulated accident than the present CAM/fan interlock control. Additionally, higher reliability of the equipment to be used for the alternative method will significantly reduce the frequency of system failures for safety control. In turn, the frequency of surveillance and functional tests to support control system availability can be reduced, thereby making resources available for other critical work.

The HEPA filter dP switch method is a commonly used control in the nuclear industry. It employs a simple static measurement system with high reliability and relatively low operating and maintenance costs. It is envisioned that the dP switch alternative will eventually replace, as primary safety control, the existing CAM interlock system which is complex and has relatively high operation and maintenance costs related to its safety classification.

6.0 IMPLEMENTATION

A Technical Bases Review (TBR) process has been conducted (CHG, 2000b) to plan and estimate the work required to put into place the dP switch alternative control for all of the affected exhaust systems. The TBR process uses integrated activity-based planning to capture all life-cycle elements of the work activity and to properly sequence them on an achievable schedule. This section summarizes the primary assumptions and results of the TBR process. More detail is found within the referenced TBR.

6.1 Project Scope

To provide the proposed alternative safety control and to provide a bounding value for estimating implementation costs, installation of a dP measurement and interlock system is assumed to be necessary on 18 of the 26 exhaust systems that are, or are expected to be, applicable to LCO 3.1.4 of the RPP TSR (see Table 1). Six portable exhausters already have the appropriate design. Future operation of one system (244-U Exhauster) is questionable. It has not yet been determined whether planned use of exhauster 296-P-32 at 244-AR will require LCO 3.1.4 controls.

The TBR planning for the plant project includes design & engineering activities, procedure development, work planning and work package development, procurement activities, shop assembly, field work, testing, work closure, and life cycle operation & maintenance costs. Necessary changes to the RPP AB are not part of the scope estimated in the TBR, as budget already exists to provide the new licensing strategy and obtain approval from ORP.

6.2 System Design

It is assumed in the TBR that a single consistent design and equipment selection will be used. A proposed standard design was assumed for the purposes of providing a bounding upper level implementation cost estimate. Actual system design to support functional requirements will be confirmed during definitive design stages. The proposed standard design (see Figure 1) includes:

- pressure taps on the ventilation housing,
- tubing to deliver static pressure signal to dP transmitters,
- dP transmitters (switches) for each filtration/stage dP measurement point,
- a programmable logic controller (PLC) for each vent system, and
- an interlock connection to each exhaust fan.

The standard assumed design is similar to the system currently installed on the Interim Stabilization exhauster (296-P-43), and it includes high and low dP measurement across each filtration stage and across the overall filtration train. The design may also include high and low dP alarms and/or dP rate-of-change alarms to warn of abnormal conditions prior to reaching interlock setpoints.

Actual system design resulting from the design process may be less rigorous in dP interlock capacity or equipment selection. This will be dependent upon formalization of functional design requirements.

6.3 Project Schedule

The schedule developed in the TBR calls for installation and functional testing to be completed for seven (7) systems before the end of fiscal year 2000. This agrees with the performance expectations of ORP Performance Incentive ORP3.2.3, Revision 0 (DOE/ORP, 1999). This schedule and completion expectation date are dependent on contractor receipt of ORP concurrence with the strategy presented here by February 15, 2000, and directed change to the RPP Multi-Year Work Plan.

The TBR schedule assumes that installation of the remaining 11 systems will occur during fiscal year 2001.

6.4 Project and Life Cycle Cost

Project cost estimated in the TBR is $2.83M for full installation and implementation for the bounding assumed design (CH2M Hill, 2000b). Appendix B summarizes the estimate in tabular form. Total annual operations and maintenance costs for the new safety control systems are estimated to be $266K per year in fiscal year (FY) 2000 dollars (CH2M Hill, 2000a). An estimate of plant life cycle cost avoidance and return on investment is provided in Section 7.0 of this document.

7.0 COST AND BENEFIT

A simple cost/benefit analysis is presented in this section. Primarily discussed are: the improvements in safety control system reliability and availability; the reduction in risk to ORP mission success; and the estimated life-cycle reduction in plant operation, maintenance, and engineering costs.

7.1 Safety Control Reliability

Because of both design simplicity and high component reliability, safety control equipment failures will be significantly reduced through the use of HEPA dP switches (versus CAMs) interlocked to shutdown the exhaust fan when high or low dP setpoints are reached.

A high level of safety system availability is currently provided by the CAM/Fan interlock system, but maintaining that level requires the use of significant manpower resources to conduct frequent operability surveillance and functional testing (LMHC, 2000). By increasing the equipment reliability of the safety control system, availability can be maintained with less frequent operability and function verifications, thereby freeing resources to support other critical work.

7.2 Mission Risk Reduction

Critical to the success of the RPP mission of tank waste retrieval, waste blending and staging, and waste feed delivery to the ORP vitrification facility is a smooth operating envelope that does not challenge transfer operations because of the failure of monitoring and control equipment. Inoperability of CAM systems that are relied upon to provide interlocked exhauster shutdown will cause interruption and termination of concurrent waste transfer operations. Penalties for interruption of waste feed delivery to the vitrification contractor British Nuclear Fuels Limited (BNFL) can be as high as $2.5 M per day as specified in the ORP/BNFL contract.

Reliance upon the proposed HEPA dP switch interlock system versus the present CAM interlock system is expected to significantly reduce safety control inoperability events that currently present risk to mission success. Simplicity of design and high component reliability for the proposed alternative are expected to reduce safety system inoperability events from a current average of more than 25 per year to less than 3 per year for the LCO 3.1.4 control function.

For the purposes of this evaluation, the selection of three dP switch interlock system failures per year was predicated upon manufacturer's reliability data for selected equipment in the assumed design, the number of critical equipment components, and consideration of a combination of other possible system operability failures resulting from environmental conditions, support system failures, delinquent maintenance, spurious alarms, and human factors. Best engineering judgement was used for this prediction.

7.3 Life Cycle Cost Avoidance

Substantial avoidance of plant life cycle costs will result from implementation of the HEPA dP switch alternative control and the phase-out of primary stack CAM systems as safety SSCs. CAMs will still be required on certain stacks[4] to meet the sampling & monitoring system environmental guidance found in DOE/EH-0173T, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (DOE, 1991). Nevertheless, it is expected that use of HEPA dP switch interlocks as the safety control for postulated HEPA failure accidents will allow for declassification of relevant stack CAM systems as General Service rather than Safety Class or Safety Significant.

As a result of CAM system declassification, substantial plant life cycle cost avoidance can be realized through reduced operational and maintenance (O&M) costs. Annual cost avoidance after implementation is estimated to be $721K in FY2000 dollars (CHG, 2000a). Table 2 summarizes the areas where it is estimated that annual O&M costs will be reduced. Additionally, $100K can be saved in FY 2001 because a planned CAM system upgrade for the 241-AW tank farm primary exhauster (296-A-27) will no longer be required. Using approved annual escalation rate of 2.1% to account for inflation, and compounding through plant closure in the calendar year 2035, life cycle cost avoidance is $35.4M (see Appendix A).

Table 2: Summary of Estimated Annual O&M Cost Avoidance

Costed Activities	Annual Savings/(Cost)
Occurrence Reporting Process Costs	$ 362,100
Operations/Craft/HPT Event Response	$ 96,800
Engineering/Maintenance/Operations Support Costs	$ 153,000
RadCon daily, bi-weekly, monthly activities	$ 59,345
Quarterly AB Functional Tests	$ 74,800
Annual Calibration[1]	$ (19,800)
Equipment Spare Parts[1]	$ (5,400)
TOTAL (FY 2000 $)	**$ 720,845**

[1] Assumes CAMs are still required, but classified as General Service versus Safety-Class or Safety-Significant

7.4 Return on Investment

Assuming approval of the alternative control is obtained from ORP, and direction is given to RPP to proceed by February 15, 2000, implementation should be

[4] DOE environmental guidance specifies that continuous monitoring should be required on emission points that could contribute a dose to members of the public greater than or equal to 0.1 mrem effective dose equivalent (EDE) per year, assuming no emission controls (HEPA filters, etc.) are in place and the entire source term is released. At Hanford, these emission points are termed "major" stacks.

completed by the close of FY 2001. If this becomes the approved project finish date, implementation costs will be fully offset with avoidance of O&M costs by April 2005. Life cycle return on investment is equal to the estimated life cycle cost avoidance of Section 7.3 ($35.4M) minus the implementation cost of Section 6.4 ($2.83M), or about $32.5M.

8.0 CONCLUSIONS

Both strong technical bases and solid business reasons exist to support the use of HEPA filter differential pressure exhauster interlock as an alternative safety control for LCO 3.1.4. The evaluation shows that the filter differential pressure option can:

1. Successfully perform the safety function of LCO 3.1.4;

2. Maintain the requisite level of safety control availability specified in the RPP FSAR;

3. Increase safety control system reliability, thereby reducing risk posed to mission success by operational disruption, exhauster shut downs, and waste transfer terminations;

4. Reduce the amount of operational and maintenance activities, thereby reducing plant life cycle costs and freeing resources to support other critical work; and

5. Result in substantial cost avoidance and returns on investment.

Additionally, the proposed alternative could:

a) Proactively prevent HEPA filter failure during a filter loading excursion by shutting down the exhauster fan well before HEPA filter high differential pressure limits are exceeded.

b) Minimize unfiltered release by securing the ventilation system immediately as HEPA filter damage occurs rather than waiting to detect contamination within the exhaust stack air stream.

REFERENCES

CHG, 2000a — Internal Memo 74600-00-DBS-009, *Estimation of Annual Cost Avoidance: Use of HEPA Delta Pressure Interlock Switch Control*, from D.B. Smet, Maintenance & Equipment Reliability, to J. R. Kriskovich, et.al, Equipment Engineering, dated January 11, 2000.

CHG, 2000b — River Protection Project Draft Technical Bases Review 240._63

DOE, 1991 — DOE/EH-0173T, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance.*

DOE/ORP, 1999 — DOE Office of River Protection Performance Incentive Number ORP3.2.3, Revision 0, *Implementation of Field Optimizations*, Contract Number DE-AC06-99RL14047

ERDA, 1976 — ERDA 76-21, *Nuclear Air Cleaning Handbook: Design, Construction, and Testing of High-Efficiency Air Cleaning Systems for Nuclear Application*

HNF, 1999 — HNF-S-0552, *Specification for Procurement and Onsite Storage of Nuclear Grade High Efficiency Particulate Air Filters*

LMHC, 1997 — HNF-SD-WM-TSR-006 Rev. 0-B, *Tank Waste Remediation System Technical Safety Requirements*

LMHC, 1999a — HNF-SD-WM-SAR-067 Rev. 1, *Tank Waste Remediation System Final Safety Analysis Report*

LMHC, 1999b — HNF-SD-WM-TSR-006 Rev. 1, *Tank Waste Remediation System Technical Safety Requirements*

LMHC, 2000 — RPP-5453, *Availability Analysis of the Ventilation Stack CAM Interlock System*

Rockwell, 1980 — Internal Letter 65260-80-0905, *AW Tank Farm Process Specifications*, from T.J. Ehli to Tank Farm Process Control File, Dated March 27, 1980.

USAEC, 1966 — W.L. Anderson and T. Anderson, "Effect of Shock Overpressure on High Efficiency Filter Units," *Proceedings of the 9th AEC Air Cleaning Conference*, USAEC Report CONF-660904, 1966

USAEC, 1973 — W.S. Gregory, *HEPA Filter Effectiveness During Tornado Conditions*, USAEC Report LA-5352-MS, Los Alamos Scientific Laboratory, 1973

Appendix A

Bases for Compensatory Control 3.1.4a
Taken from ECN #642484

(4 pages including cover page)

B 3.1 CONFINEMENT

B 3.1.4a HEPA Filter Differential Pressure and Stack High Radiation Systems

BASES

BACKGROUND

This control is a compensatory measure per the *Tank Farms Basis for Interim Operation Compliance Implementation Plan*, HNF-SD-WM-IMP-001 Revision 0, March 26, 1997 (CIP). This control is used to compensate for those ventilation systems that currently do not have OPERABLE ventilation CAM interlocks as needed per LCO 3.1.4, "Ventilation Stack CAM Interlock Systems."

The CIP requires the simultaneous operability of three distinct systems on exhaust ventilation: the HEPA filter low differential pressure interlock with the ventilation fan, the HEPA filter high differential alarm with operator ventilation fan shutdown, and high radiation alarm with operator ventilation fan shutdown. Further operability details are identified in the "JCO" section of this Bases.

These systems provide compensatory protection against the unfiltered release of radiological and toxicological material originating from sprays within the tanks or filter failure/damage. The alarms and interlocks do not prevent waste spray leak, high pressure, or high temperature events from occurring, but mitigate the potential consequences by terminating further discharges through the ventilation stack.

APPLICABLE SAFETY ANALYSES

These compensatory controls provide alternative protection for two accident scenarios: (1) spray leak and (2) HEPA filter fire (and subsequent unfiltered release). See LCO 3.1.4 Bases for further safety analysis background. As compensatory controls they are not credited in the safety analysis, though some were identified as defense-in-depth. The primary safety function of LCO 3.1.4 is to confine releases and ensure minimal contaminant dispersion by shutdown of the ventilation fan. The combination of controls in this compensatory measure, though not analyzed nor credited in the safety analysis, provide a high level of assurance of confinement and fan shutdown.

<u>HEPA Filter Low Differential Pressure Interlock</u>

This interlock ensures that a missing HEPA filter would automatically shut down the ventilation fan. Also, a damaged filter/seal would probably activate this interlock. Operability is defined for an interlock at a single (first) filter, thus for ventilation systems with dual HEPA

BASES

filters, this interlock provides better assurance since the probability of common cause failure for both HEPA filters/seals is low.

HEPA Filter High Differential Pressure Alarm

High differential pressure across a filter is only an indication of material in the air stream, and by its very nature minimizes contamination spread out of the ventilation system. The spray scenario would slowly build up material evenly across a filter because of the low flow velocities, causing high differential pressure. If localized wicking would occur at the filter (a funnel pattern processed through the filter), high differential pressure setpoints would still be exceeded. Alarms would cause personnel to shut down the ventilation fan or switch ventilation trains. Operability is defined for an alarm at a single (first) filter, thus for ventilation systems with dual HEPA filters, the second HEPA filter provides assurance of maximum filtering efficiency.

High Radiation Alarm

This alarm is a notification of high radiation as sensed by the exhaust ventilation stack CAM. It is a final indication of potential filter breakthrough. Personnel would shut down ventilation flow upon alarm indication.

LCO

The control is summarized by a single statement because the CIP requires three simultaneous controls, and actions for inoperability of each are identical. "HEPA Filter Differential Pressure" summarizes both the low differential pressure interlock and high differential pressure alarm. "Stack High Radiation" summarizes the exhausts ventilation high radiation CAM alarm. If one of the three compensatory measure controls fails its operability requirement listed below then the system is considered inoperable, requiring ACTIONS entry.

HEPA Filter Low Differential Pressure Interlock
Operability: Shut down respective exhaust ventilation fan when differential pressure across one HEPA filter, at rated flow, is ≤ 0.2" WG.

Normal pressure drop across a clean HEPA filter is 0.85-1" WG. The absence of a filter or improperly seated seal would lower the pressure drop way below the bottom limit of 0.2" WG. This limit also represents a conservative indication of filtration loss, that will immediately shut down ventilation flow.

HEPA Filter High Differential Pressure Alarm

BASES

Operability: Alarm at continuously manned facility when differential pressure across first HEPA filter in a series, at rated flow, is ⟨6.0" WG.

The design basis pressure drop of a HEPA filter is 10" WG. The limit of 6.0" WG allows a 4" WG margin of safety during which corrective actions may be performed without danger of filter failure. This limit represents a conservative indication of potential accident conditions while protecting filter integrity.

<u>High Radiation Alarm</u>
Alarm at continuously manned facility when stack CAM radiation level is ≤ 10,000 cpm.

This limit is based upon the same criteria as the interlock value LCO 3.1.4 value, specifically that is above normal field conditions, but is estimated (without analysis) to capture radiation releases indicative of the accidents. This limit is implemented in the field by establishing alarm values at the most sensitive condition without activation from normal radon releases, with appropriate consideration of CAM collection and sampling rates and filter efficiencies.

Appendix B

Estimated Costs:
HEPA Filter Differential Pressure Switch & Exhaust Fan Interlock Installation
(2 pages including cover page)

HEPA Filter Differential Pressure Switch & Exhaust Fan Interlock Installation Estimated Costs				
	FY 2000		FY 2001	
Task Description	FY 2000 Estimated Cost per Vent System	FY 2000 Estimated Total Cost (7 installations)	FY 2001 Estimated Cost per Vent System	FY 2001 Estimated Total Cost (11 installations)
PROJECT MANAGEMENT	$8,513	$59,591	$8,528	$93,808
PREPARE WORK PACKAGE	$28,947	$202,629	$28,883	$317,713
PERFORM FIELD WORK	$44,121	$308,847	$44,200	$486,200
PREPARE PROCEDURES	$69,822	$368,754	$69,676	$766,436
ENGINEERING		$55,829		
PROCUREMENT		$173,466		
Total		FY'00 $1,169,116		FY'01 $1,664,157
Grand Total	$2,833,273			

Appendix C

Life Cycle Cost Avoidance
HEPA Filter dP Switch Safety Control
(3 pages including cover page)

HEPA Filter dP Switch Safety Control: Life Cycle Cost Avoidance					
Fiscal Year	Annual Cost Avoidance (FY 2000 Dollars)	Annual Expense Escalation Rate (%)	Expense Compounded Rates	Annual Cost Avoidance Adjusted for Inflation (escalated & compounded)	Cumulative Life Cycle Cost Avoidance
2000	$-	0%	0.000	$-	$-
2001	$100,000.00	2.1%	0.021	$102,100.00	$102,100.00
2002	$720,845.00	2.1%	0.042	$751,120.49	$853,220.49
2003	$720,845.00	2.1%	0.064	$766,979.08	$1,620,199.57
2004	$720,845.00	2.1%	0.087	$783,558.52	$2,403,758.09
2005	$720,845.00	2.1%	0.110	$800,137.95	$3,203,896.04
2006	$720,845.00	2.1%	0.133	$816,717.39	$4,020,613.42
2007	$720,845.00	2.1%	0.157	$834,017.67	$4,854,631.09
2008	$720,845.00	2.1%	0.181	$851,317.95	$5,705,949.03
2009	$720,845.00	2.1%	0.206	$869,339.07	$6,575,288.10
2010	$720,845.00	2.1%	0.231	$887,360.20	$7,462,648.30
2011	$720,845.00	2.1%	0.257	$906,102.17	$8,368,750.46
2012	$720,845.00	2.1%	0.283	$924,844.14	$9,293,594.60
2013	$720,845.00	2.1%	0.310	$944,306.95	$10,237,901.55
2014	$720,845.00	2.1%	0.338	$964,490.61	$11,202,392.16
2015	$720,845.00	2.1%	0.366	$984,674.27	$12,187,066.43
2016	$720,845.00	2.1%	0.394	$1,004,857.93	$13,191,924.36
2017	$720,845.00	2.1%	0.424	$1,026,483.28	$14,218,407.64
2018	$720,845.00	2.1%	0.454	$1,048,108.63	$15,266,516.27
2019	$720,845.00	2.1%	0.484	$1,069,733.98	$16,336,250.25
2020	$720,845.00	2.1%	0.515	$1,092,080.18	$17,428,330.42
2021	$720,845.00	2.1%	0.547	$1,115,147.22	$18,543,477.64
2022	$720,845.00	2.1%	0.580	$1,138,935.10	$19,682,412.74
2023	$720,845.00	2.1%	0.613	$1,162,722.99	$20,845,135.72
2024	$720,845.00	2.1%	0.647	$1,187,231.72	$22,032,367.44
2025	$720,845.00	2.1%	0.681	$1,211,740.45	$23,244,107.88
2026	$720,845.00	2.1%	0.717	$1,237,690.87	$24,481,798.75

HEPA Filter dP Switch Safety Control: Life Cycle Cost Avoidance (cont)

Fiscal Year	Annual Cost Avoidance (FY 2000 Dollars)	Annual Expense Escalation Rate (%)	Expense Compounded Rates	Annual Cost Avoidance Adjusted for Inflation (escalated & compounded)	Cumulative Life Cycle Cost Avoidance
2027	$720,845.00	2.1%	0.753	$1,263,641.29	$25,745,440.03
2028	$720,845.00	2.1%	0.789	$1,289,591.71	$27,035,031.74
2029	$720,845.00	2.1%	0.827	$1,316,983.82	$28,352,015.55
2030	$720,845.00	2.1%	0.865	$1,344,375.93	$29,696,391.48
2031	$720,845.00	2.1%	0.905	$1,373,209.73	$31,069,601.20
2032	$720,845.00	2.1%	0.945	$1,402,043.53	$32,471,644.73
2033	$720,845.00	2.1%	0.985	$1,430,877.33	$33,902,522.05
2034	$720,845.00	2.1%	1.027	$1,461,152.82	**$35,363,674.87**

NOTE: Because TF Deactivation Program and SST and DST Retrieval & Closure schedules are not fully developed in the MYWP, these escalated costs use the assumption that the applicable exhausters will run to the end of the plant life cycle in the year 2035.